

Air Transportation System Planning and Design




Air Transportation System Planning and Design : Contents

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|--------|--|
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| 2 | Characteristics of the aircraft, Airport Requirements, site selection, layout plan and financial plan, |
| 3 | Forecasting air travel demand, Air freight demand |
| 4 | Geometric Design of runway, taxiway, aprons, Design of Passenger Terminal, analysis of flow through terminals, |
| 5 | Design of air cargo facilities, Airfield pavement and drainage design, |
| 6 | Environment impact of Airports. |
| 7 | Air traffic control lighting and signing, |
| 8 | Airport capacity and configuration, parking configurations and apron facilities |



Texts/References

- R. Horonjeff and F. X. Mckelvey, *Planning & Design of Airports*, McGraw Hill, New York, 1994.
 - S. K. Khanna, M. G. Arora and S. S. Jain, *Airport Planning and Design*.
- 




Advantages of Air Transportation

● Rapidity:

- Air transport maintains the highest speed. Designs have been finalized for supersonic jets which travel faster than sound.

● Continuous Journey:

- Air transport mode is continuous over land and water without loss of the time unlike other modes of transport.
- 



Advantages of Air Transportation

Accessibility :

- Air transport has the unique ability to open up any region that is inaccessible by other means of transportation.






Limitations of Air Transportation

● Weather Conditions:

- The weather conditions greatly affect the operation of air transport.
- Foggy days are absolutely not convenient for the landing and take off operations of aircraft.


● Capacity:

- Weight carrying capacity of aircrafts is the lowest amongst other carriers of transport. For extra luggage heavy payment is involved.
- 



Limitations of Air Transportation


Operating Expenses:

- Flight charges are comparatively very high.
 - Factors responsible for high cost are:
 - Cost of air vehicles
 - Traffic control systems
 - Limited seating capacity (?)
 - High freight charges
- 




Limitations of Air Transportation

Flight Rules:

- Air transport is more beneficial for the international travel, in which rules laid down by ICAO (International Civil Aviation Organization) have to be followed.
 - ICAO is one body which develops standards and laws for international flights
- 



What is AIRPPORT?

- An airport is a **facility** where passengers **connect** from ground transportation to air transportation.
 - An airport is a location where aircraft such as airplanes, helicopters **take off and land**.
 - Aircraft may also be **stored or maintained** at an airport.
 - An airport should have runway for takeoffs and landings, buildings such as **hangars and terminal buildings**.
- 

AIRPORT LAYOUT (Landing Area)



AIRPORT LAYOUT (Landing Area)



What is AIRFIELD ?

- *AIRFIELD* is an area where an aircraft can land and take off, which may or may not be equipped with any navigational aids or markings. Many grass strips are also designated as airfields.



What is Aerodromes?


- A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.





Difference between Airport and Aerodromes

| | Airport | Aerodrome |
|------------|---|--|
| Guidelines | Must meet all guidelines as set for an airport by the ICAO. | No specific guidelines except safety regulations |
| Functions | Allow a plane to land and takeoff. Allow a plane to be stored. Guide general air traffic. | Allow a plane to land and takeoff. |
| Consists | Runway, Helipad, Hangers, Control Towers, Terminal Buildings, Water for takeoffs and landings, air traffic control, passenger facilities such as restaurants and lounges, and emergency services. | Some sort of an area for planes to land and takeoff. |





Airport Authority of India (AAI)

- Airports Authority of India (AAI) manages a total of 125

Airports:

- 11 International Airports,
- 08 Customs Airports,
- 81 Domestic Airports
- 25 Civil Enclaves.



Airport Authority of India (AAI)

- During the year 2013-14, all AAI operational airports taken together handled
 - 1.54 million aircraft movements
 - 168.92 million passengers
 - 2.28 million tonnes of freight.

Airport Authority of India (AAI)

TRAFFIC TRENDS (2013-14 Vs 2012-13)

| TRAFFIC CATEGORY | FOR THE YEAR | | |
|------------------------------------|------------------|------------------|------------|
| | 2013-14 | 2012-13 | % CHANGE |
| A/c Movements (in numbers) | | | |
| International | 335970 | 313909 | 7.0 |
| Domestic | 1200645 | 1164902 | 3.1 |
| TOTAL | 1536615 | 1478811 | 3.9 |
| Passengers (in numbers) | | | |
| International | 46619723 | 43033830 | 8.3 |
| Domestic | 122296319 | 116367526 | 5.1 |
| TOTAL | 168916042 | 159401356 | 6.0 |
| Freight (in tonnes) | | | |
| International | 1443066 | 1406334 | 2.6 |
| Domestic | 836088 | 784215 | 6.6 |
| TOTAL | 2279154 | 2190549 | 4.0 |
| Mail (in tones) | | | |
| International | 7612 | 8897 | -14.4 |
| Domestic | 41427 | 37245 | 11.2 |
| TOTAL | 49039 | 46142 | 6.3 |



Aeroplane Component Parts



Forces Acting on Aircraft



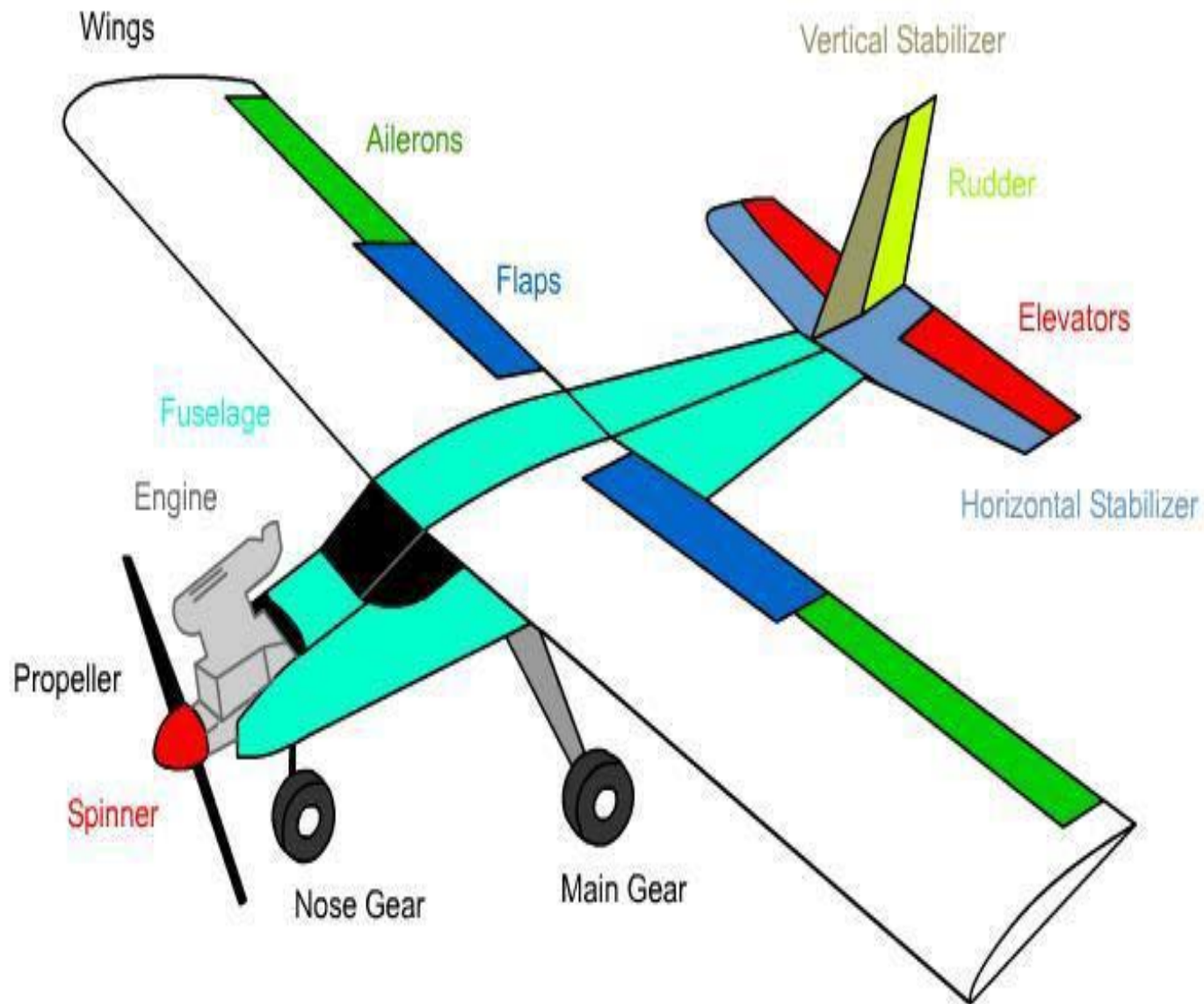


Tail

Elevator

← Rudder





1.Engine

2.Propeller

3.Fuselage

4.Wings

5.Three
controls

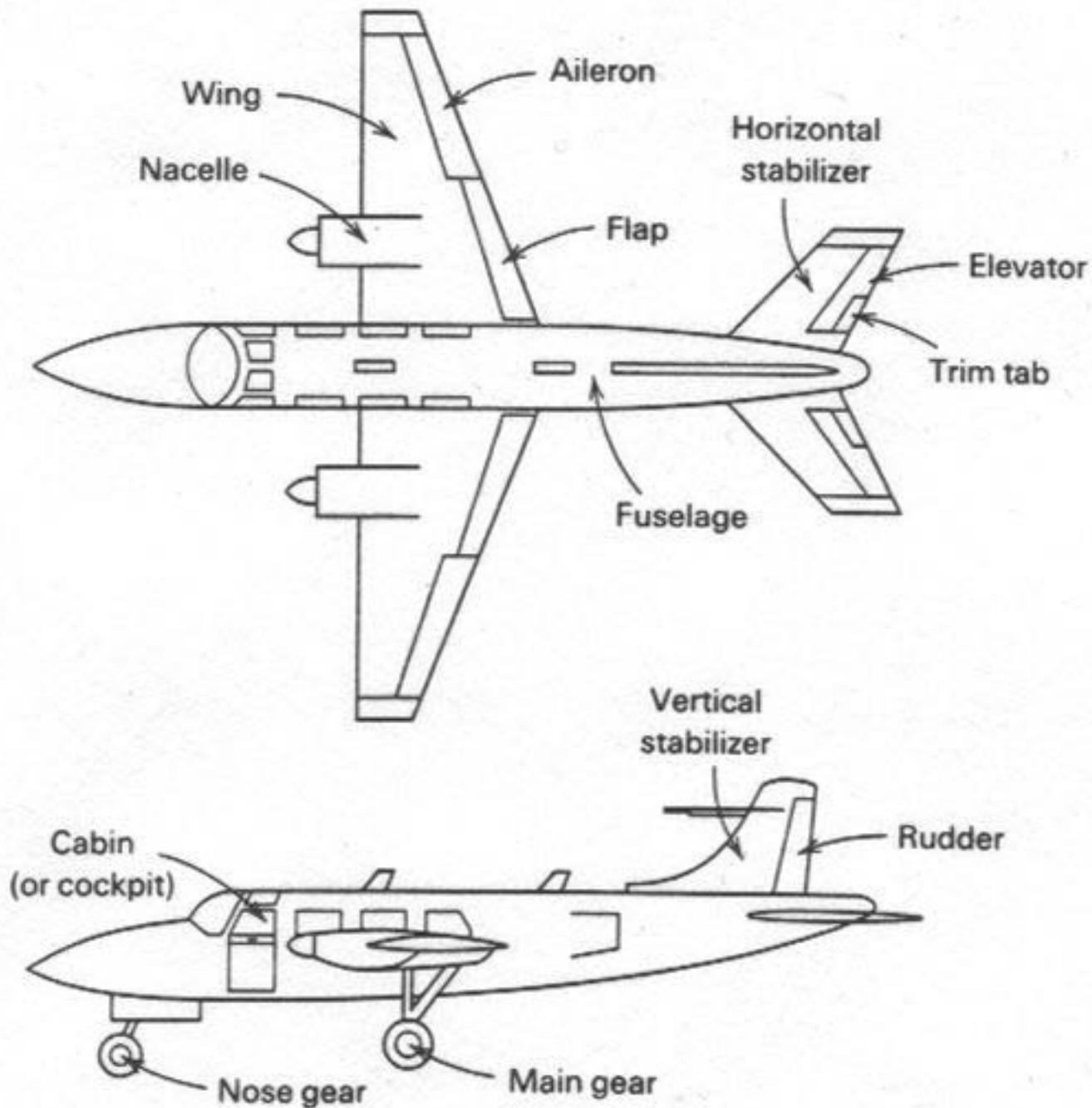
1. Elevator

2. Rudder

3. Aileron

6.Flaps

7.Tricycle
under
carriage



1.Engine

2.Propeller

3.Fuselage

4.Wings

5.Three
controls

1. Elevator

2. Rudder

3. Aileron

6.Flaps

7.Tricycle
under
carriage



Engine

- **Function** : to provide a force for propelling the aircraft through the air.

- **Aircraft engine types:**

1. Piston Engine
2. Jet Engines – Turbo jet, Turbo fan or prop, Ram jet, etc.





Engine – Subsonic and Supersonic

Subsonic Engines

This category contains most of the commercial jets that are used today to move passengers and cargo. Eg. Boeing 777, 747, etc.

The speed is just below the speed of sound.

Speed : 560 – 1200 kmph

Engines today are lighter and more powerful and can travel quickly with large loads of people or goods

Supersonic Engines

Planes in this regime have specially designed high performance engines. Eg. Concorde

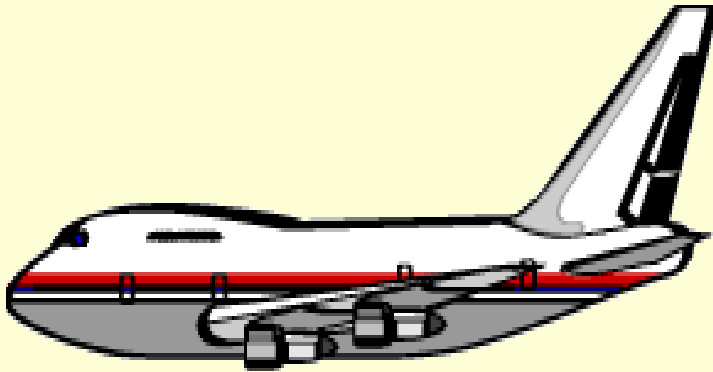
These planes can fly up to 5 times the speed of sound.

Speed : 1200 – 5600 kmph

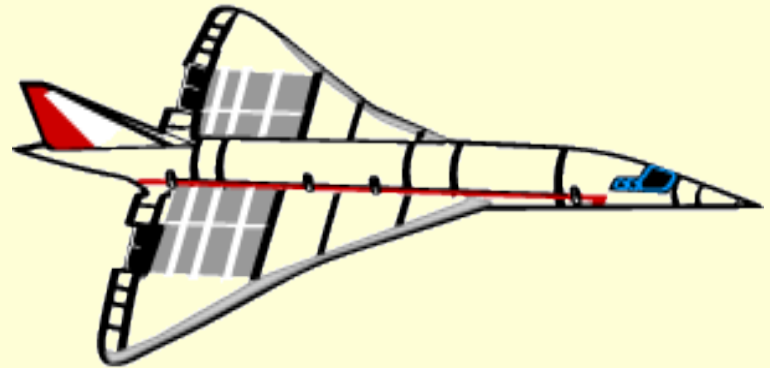
They are also designed with lightweight materials to provide less drag.



Engine – Subsonic and Supersonic



Boeing 747



Concorde

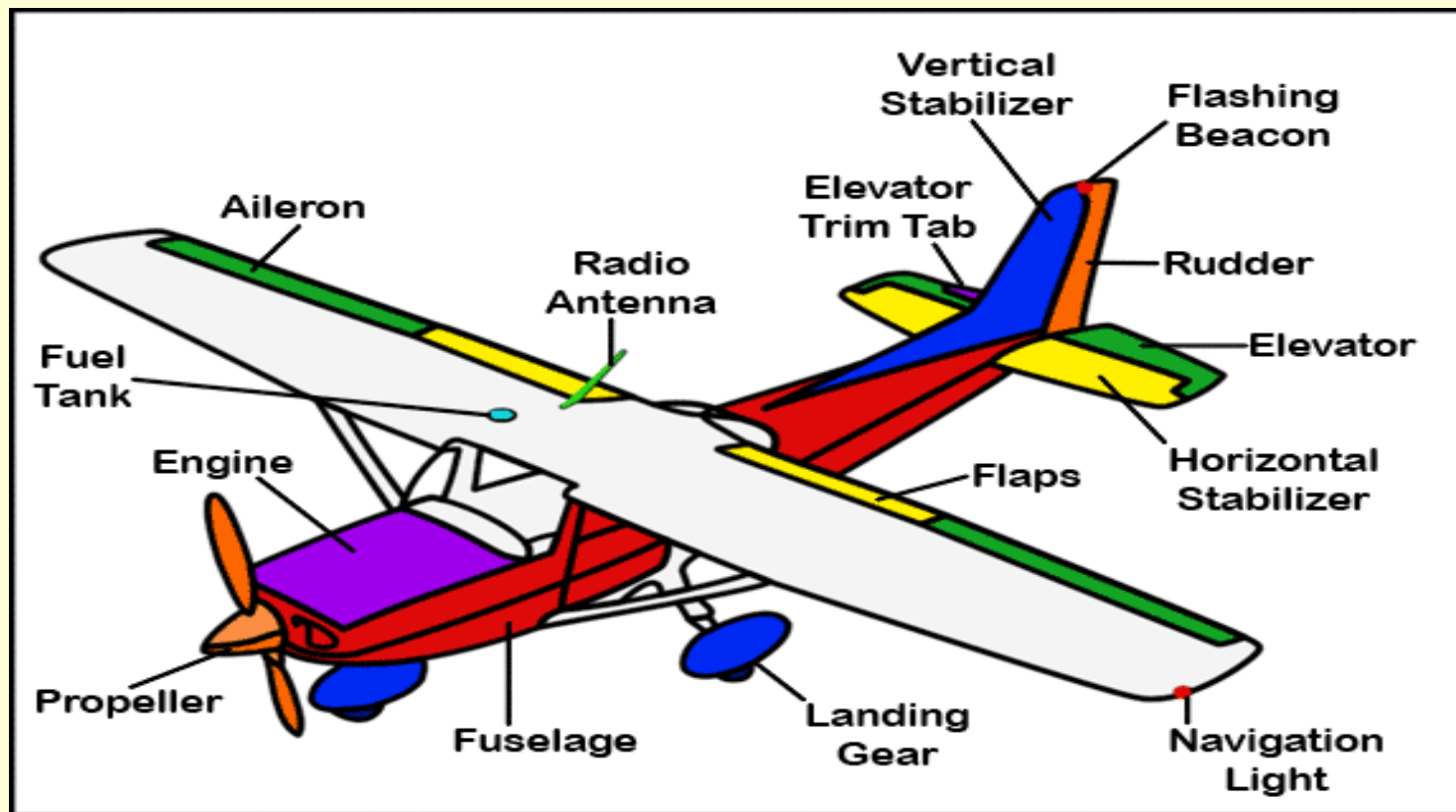
Propeller

- Provided in the conventional piston engine aircrafts as well as in turbo prop engines.
- When engine and propeller are in front, the machine is described as a **tractor type** and near the wing is known as **pusher installation**.



Propeller

- **Function** : The blades deflect air backwards with an acceleration and thus impart forward thrust to the aeroplane.





Fuselage

- It forms the main body of the aircraft and provides for power plant, fuel, cockpit, passengers, cargo, etc.
- It should be **large** enough to give **sufficient tankage space** and yet should be **small** to reduce the **wind resistance**.
- It is shaped to a **fine point** at the rear end.

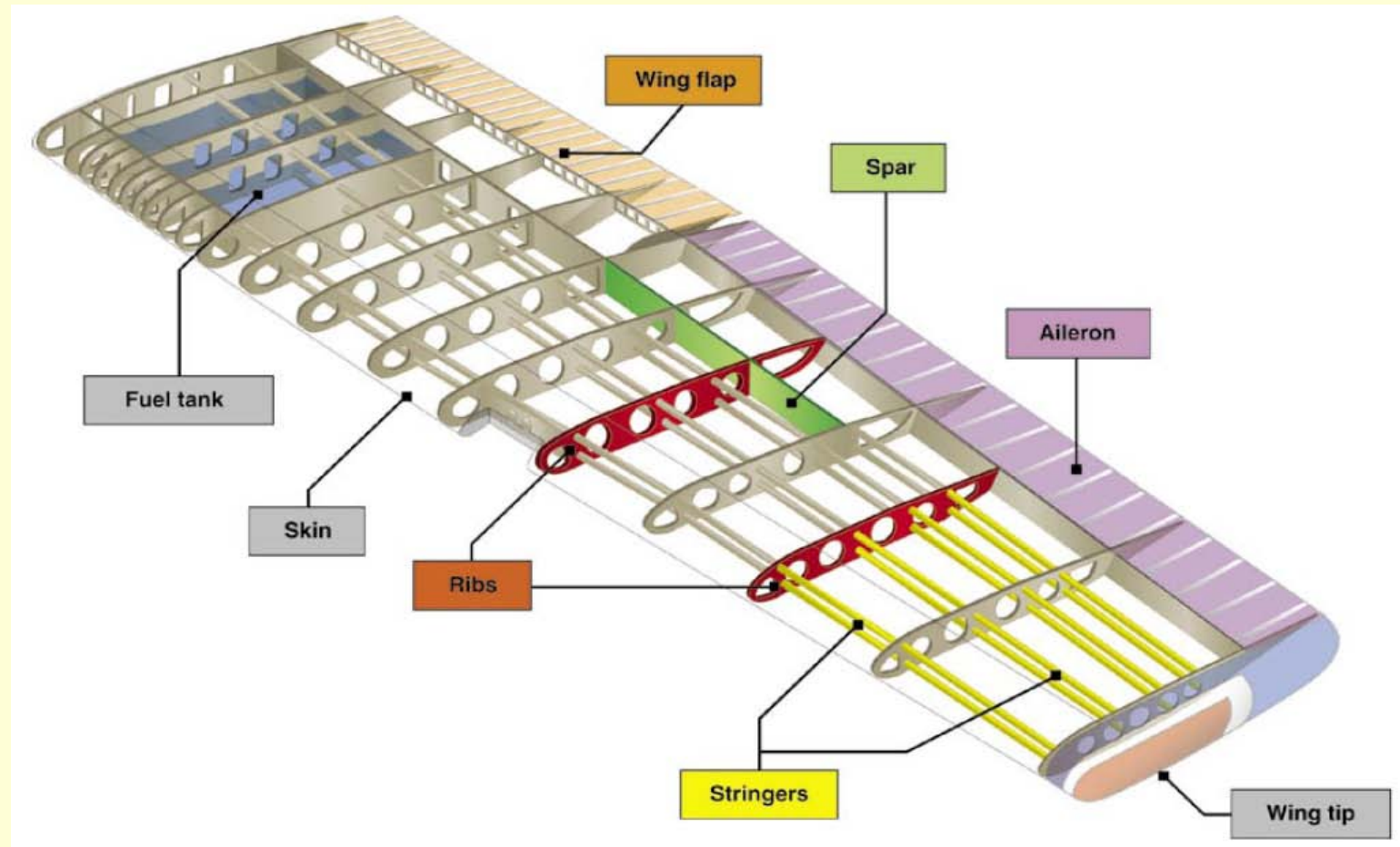


Wings

- The purpose of an aircraft wing is to support the machine in the air when the engine has given it the necessary forward speed.
- The wing structure must be torsionally stiff to resist forces which tend to twist the wings.
- It should be strong enough to resist the bending forces.



Frame work of Wings

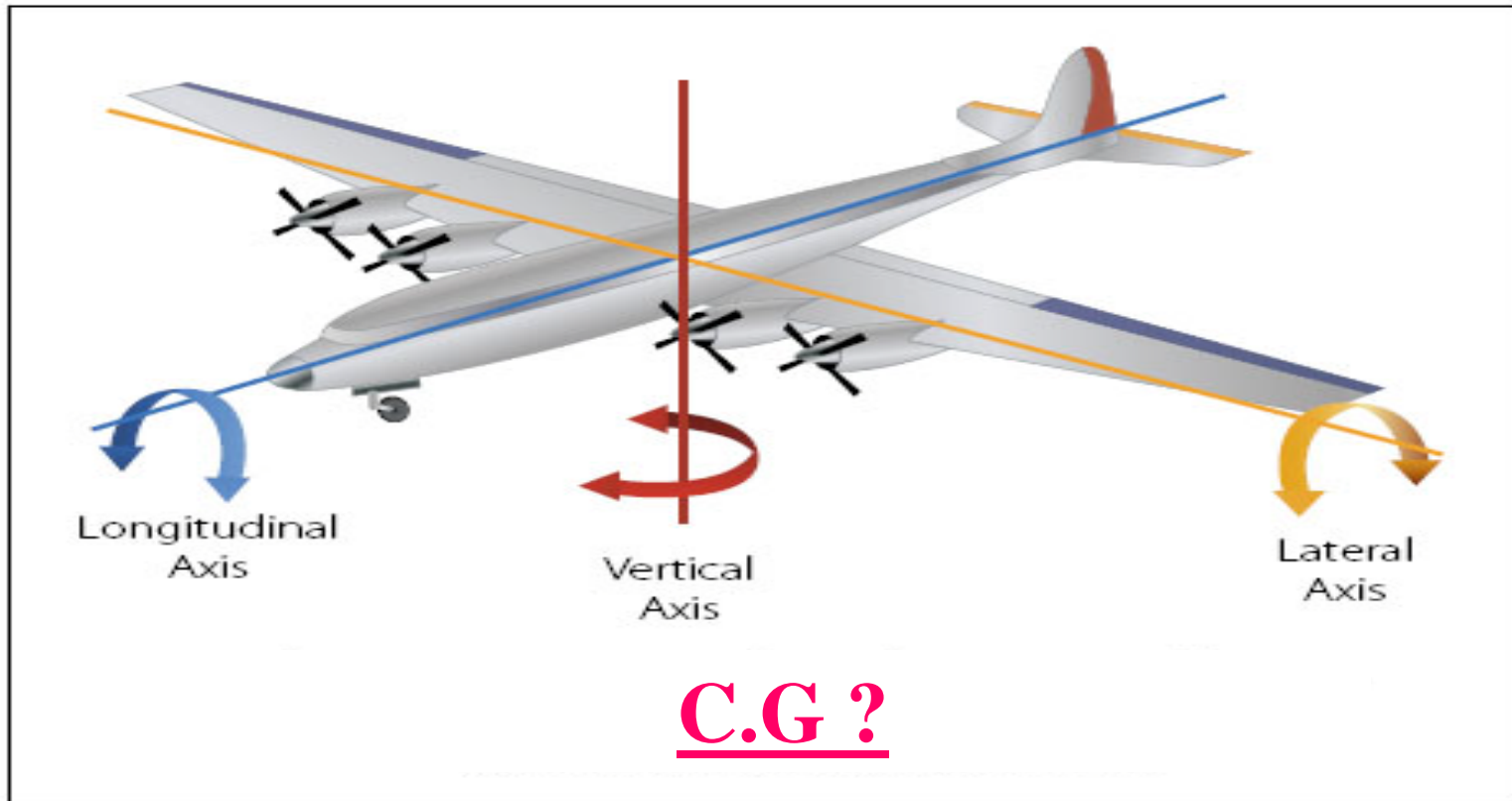




Three Controls

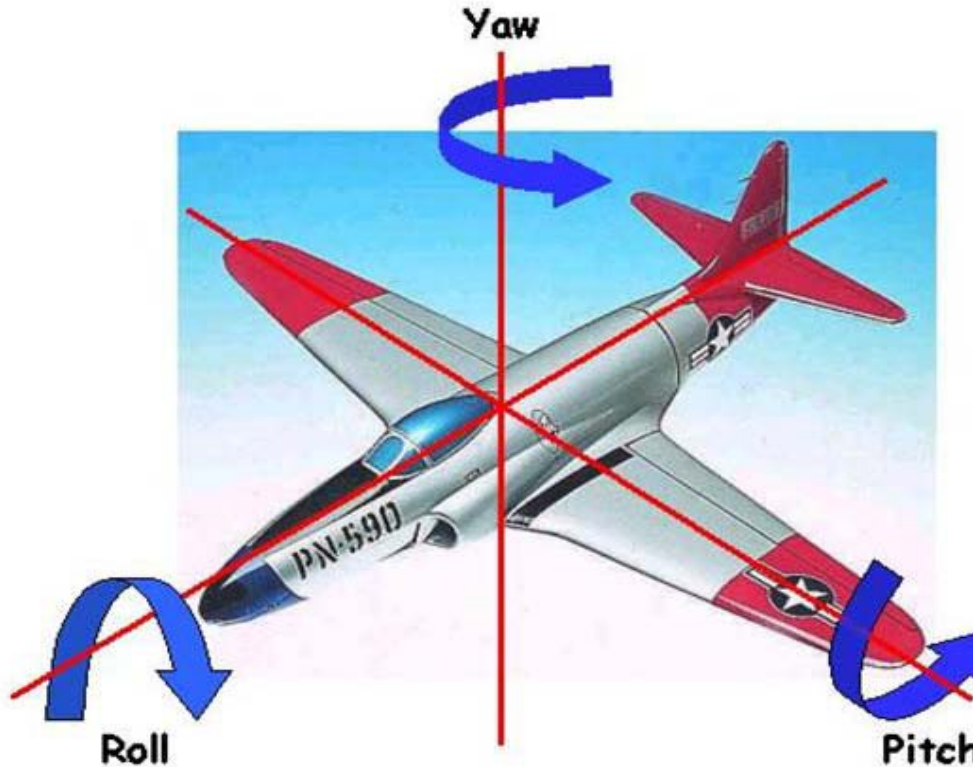


- Aircraft rotates about three axis in space.



Three Controls

- Movements along X, Y and Z axis are called as **Rolling**, **Pitching** and **Yawing** respectively.



The aircraft **ROLLS** around the longitudinal or fuselage axis.

The aircraft **PITCHES** around the lateral or wing axis.

The aircraft **YAWS** around the vertical axis.

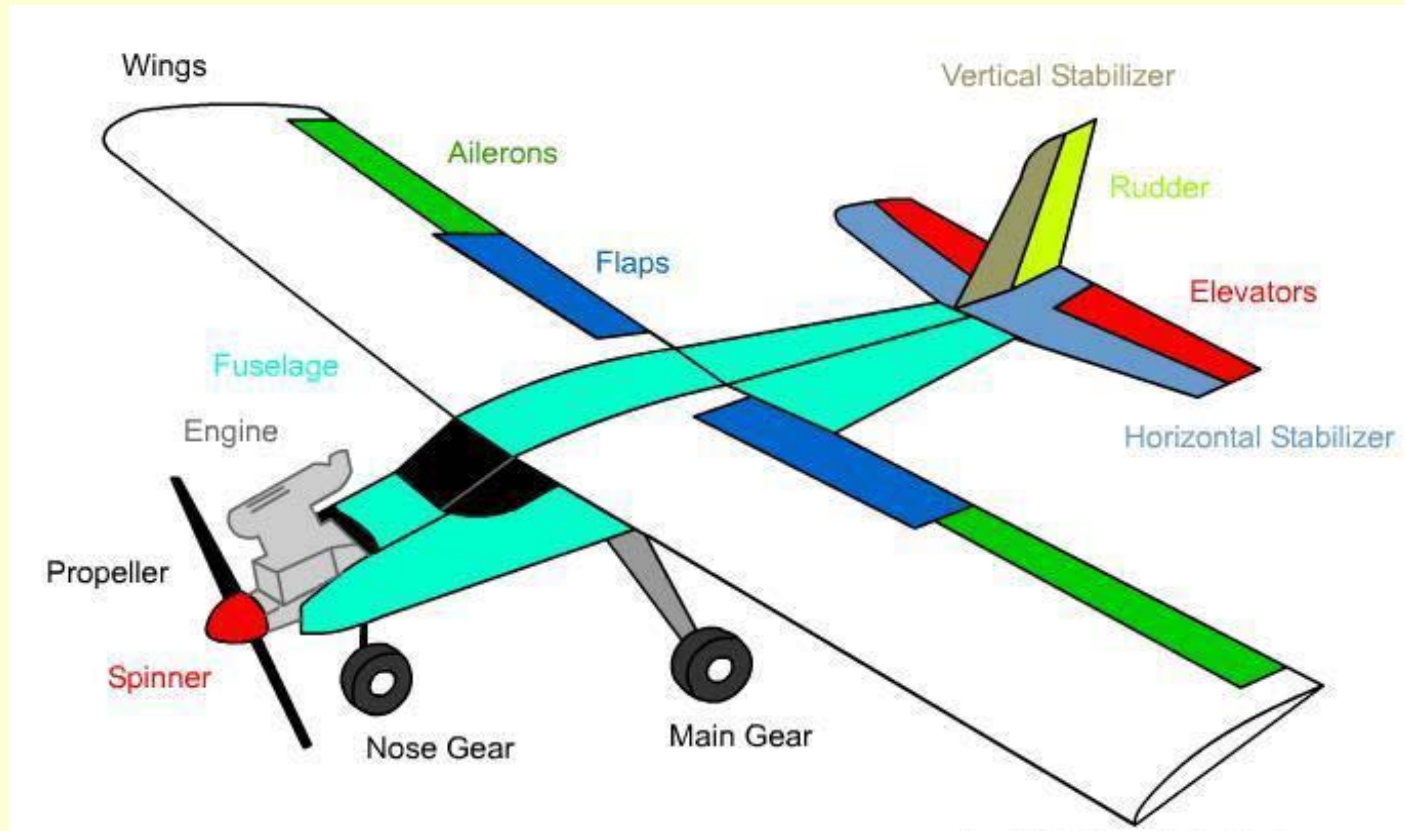
Pitching
(up and down movements)

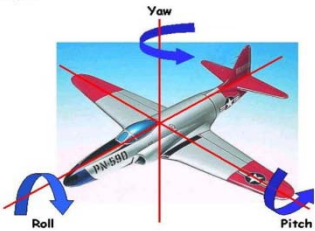
Yawing (left or right turning)

Rolling (clockwise or anticlockwise)

Three Controls

- To control these movements aeroplane is provided with three controls : (i) Elevator (ii) Rudder (iii) Aileron.

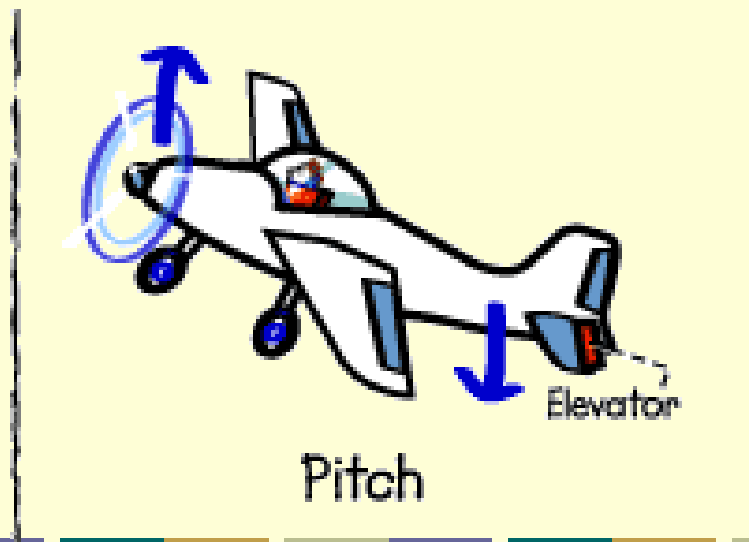
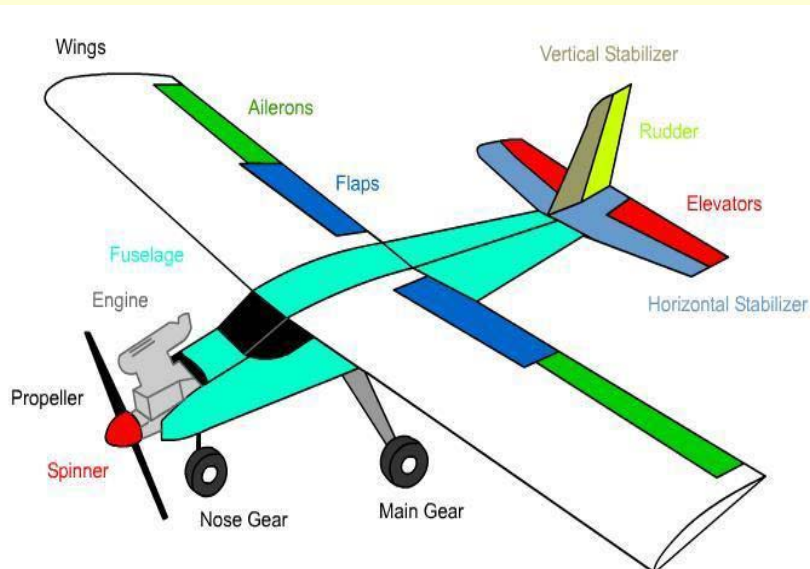




Three Controls

● Function of Elevator :

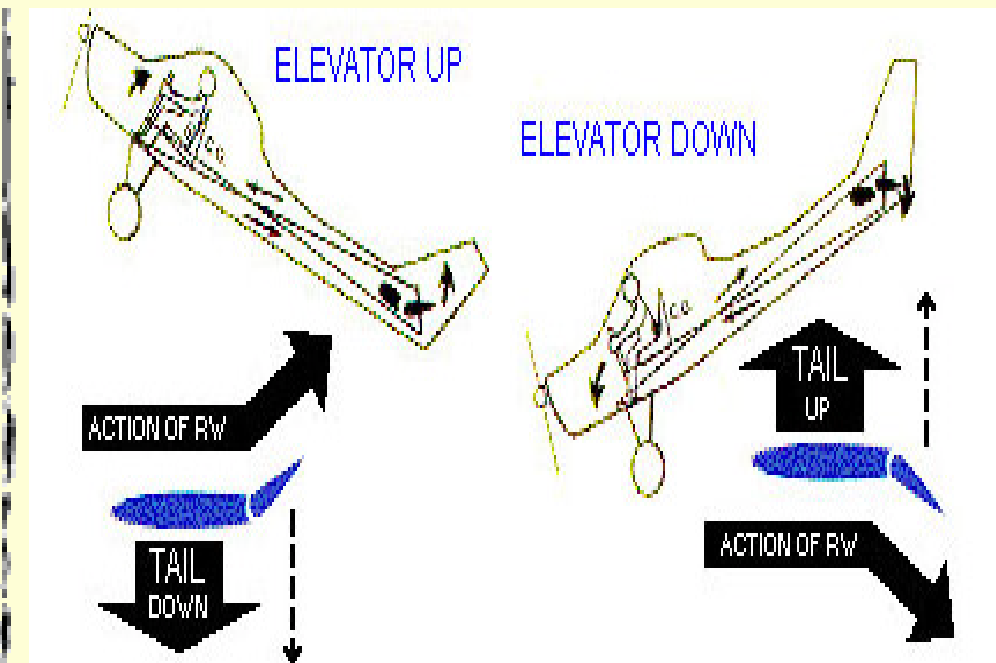
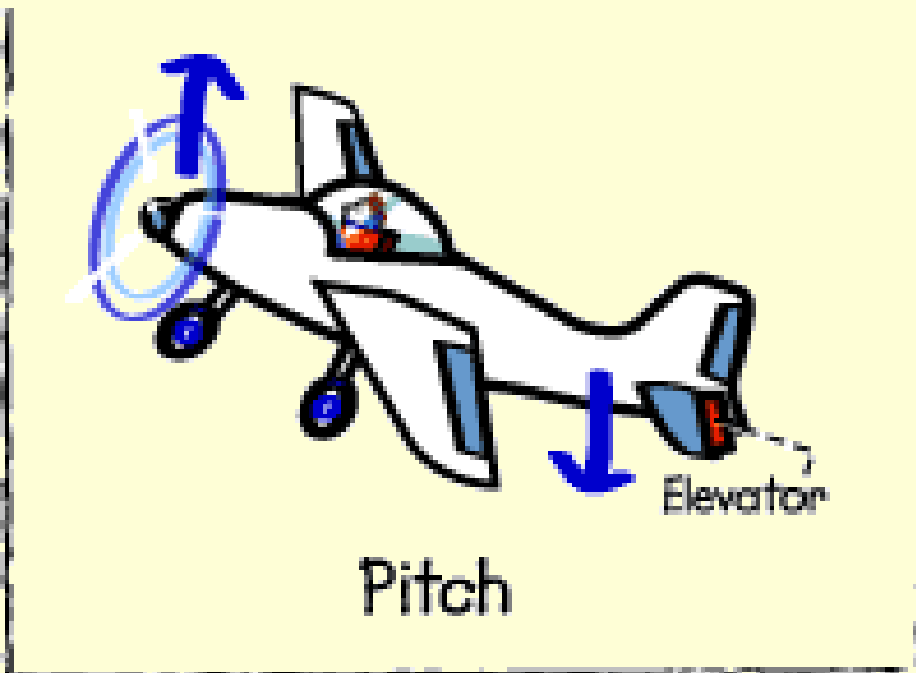
- It consists of **two flaps** capable of **moving** up and down through an **angle of 50-60** .
- They are hinged to a fixed horizontal **stabilizer**.
- It controls **pitching** (up and down movements) of aircraft.



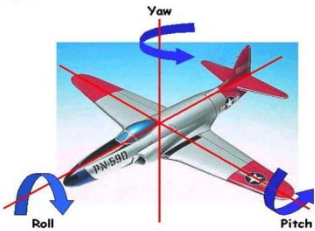
Three Controls

● Function of Elevator :

- It controls **pitching** (up and down movements) of aircraft.



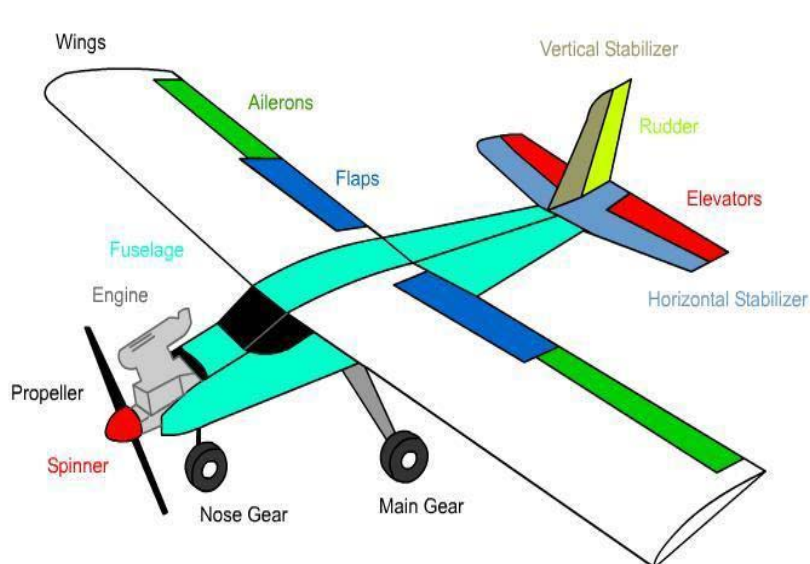
Position of Elevator Flap to lift Aircraft UP ?



Three Controls

Function of Rudder :

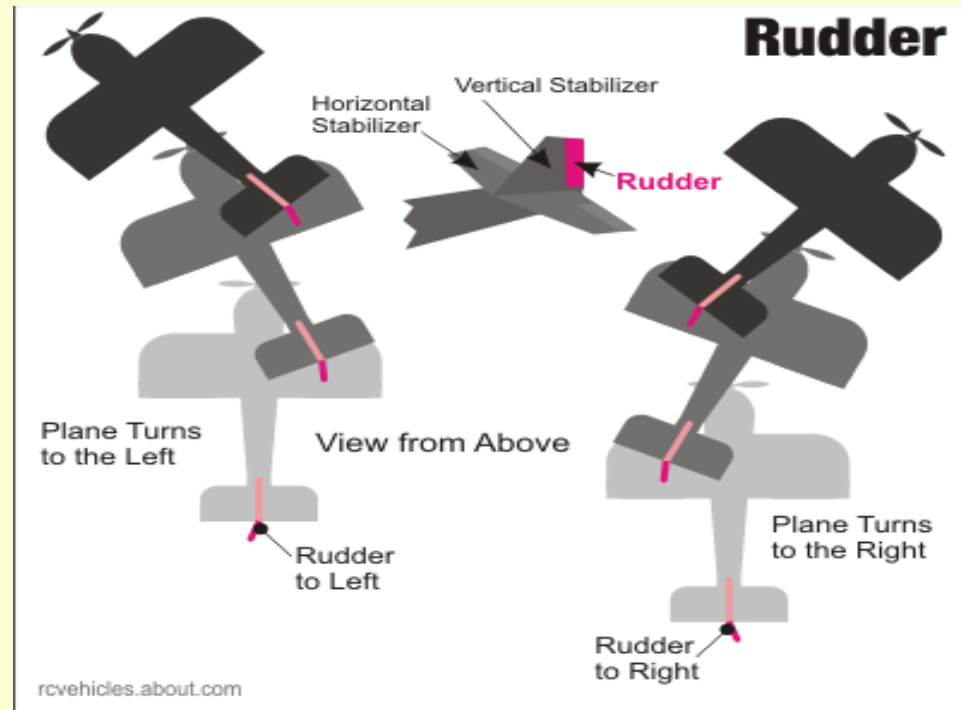
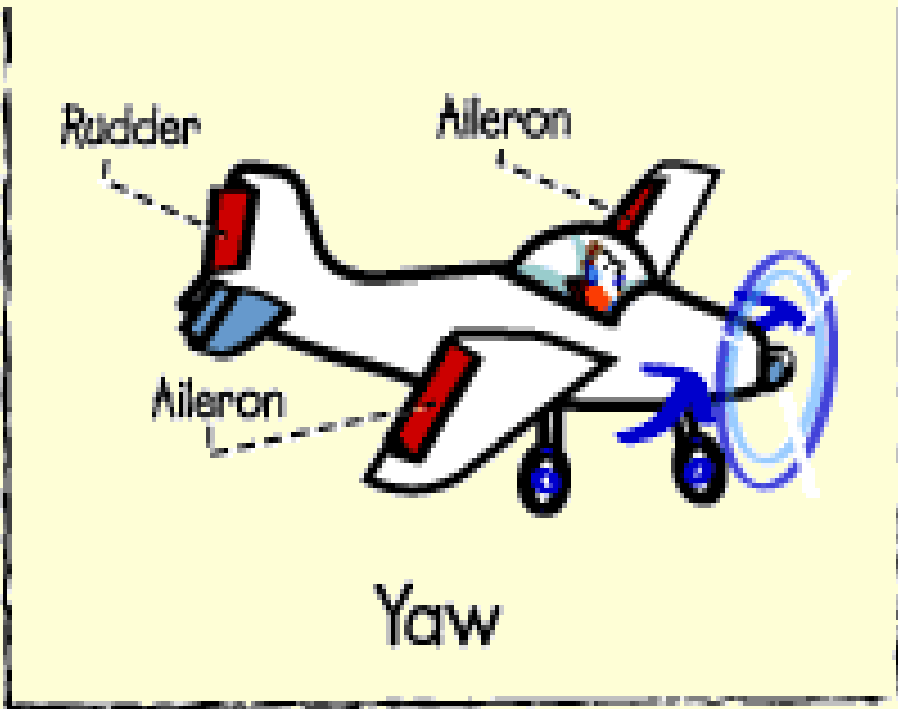
- It consists of **one flap** capable of **moving** left or right through an **angle of 30°**.
- It is hinged to a fixed vertical **stabilizer**.
- It controls **turning** or **yawing** (left or right turning) of aircraft.



Three Controls

● Function of Rudder :

- It controls **turning** or **yawing** (left or right turning) of aircraft.

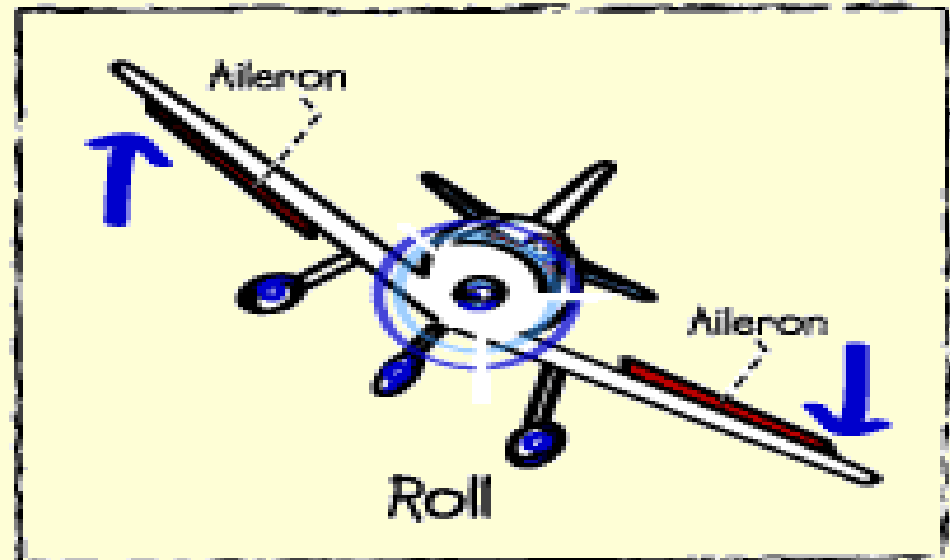
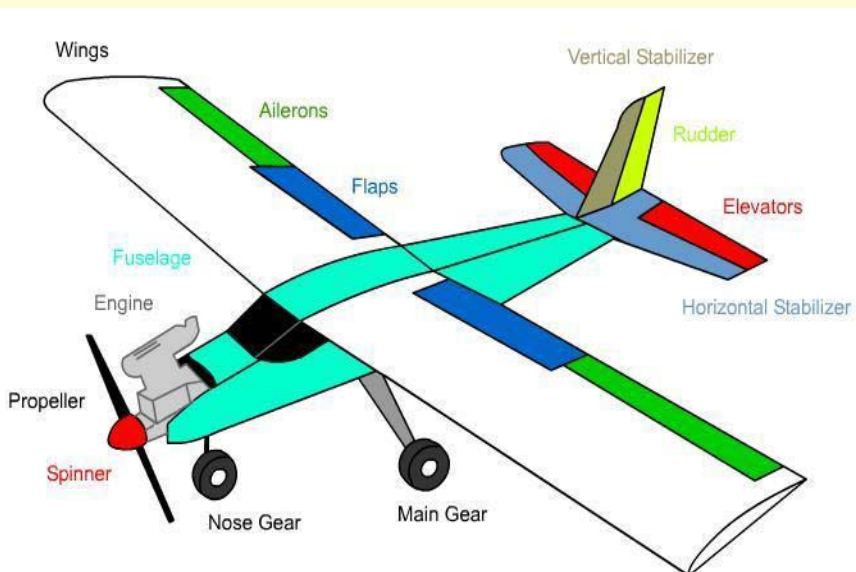


Position of Rudder Flap to turn Aircraft Left ?

Three Controls

● Function of Aileron :

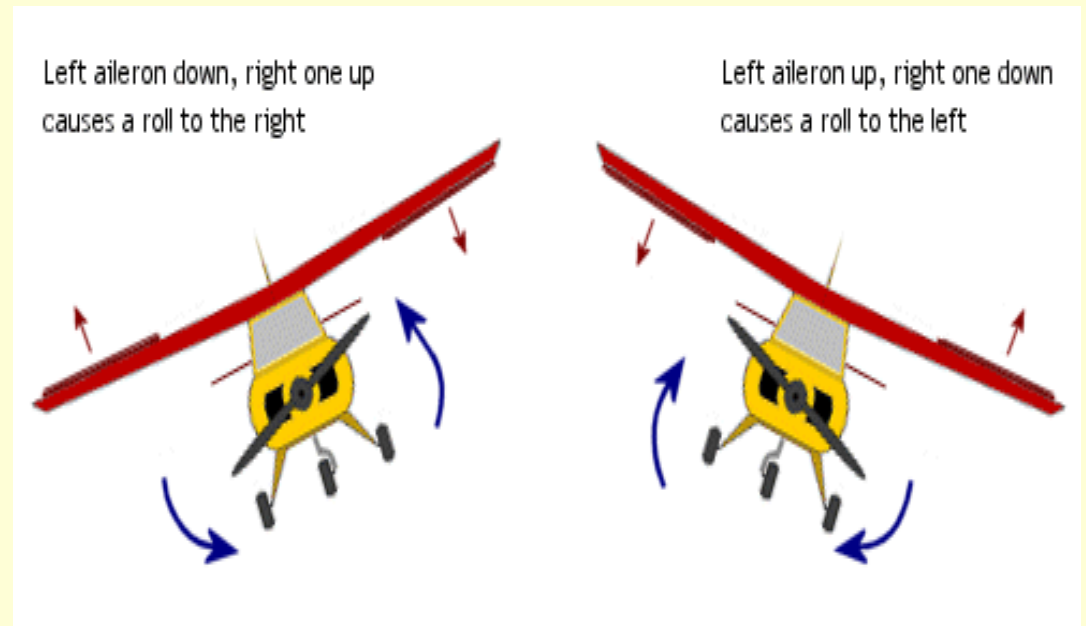
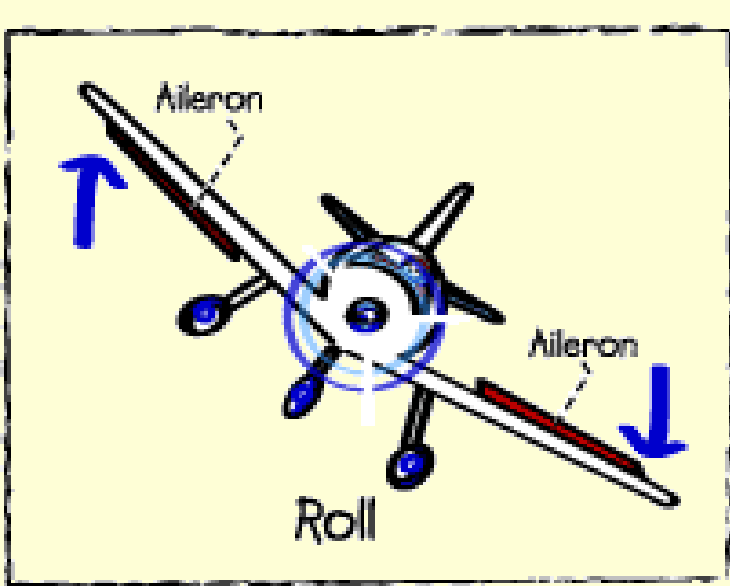
- It is hinged flap which is fixed in the **trailing edge of the wing**.
- It is rigged such that when **one wing** of aileron is **pulled up** other is **pulled down**.
- It controls **rolling** (clockwise or anticlockwise) of aircraft.



Three Controls

● Function of Aileron :

- It controls **rolling** of aircraft.



Position of Aileron to roll Aircraft anticlockwise ?



Flaps

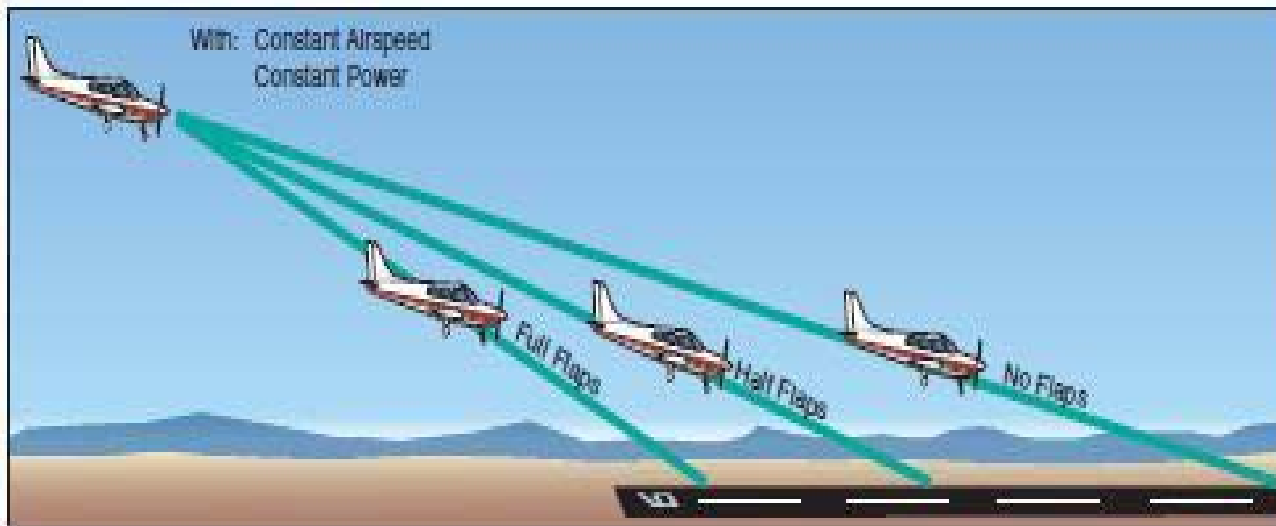
- These are somewhat similar to ailerons and are used for **increasing the lift on aerofoils**.
- They are fitted in the **inner portion of the wings**.
- Arranged such that both flaps **pulled down together**.





Flaps

- They shorten takeoff and landing distances. Flaps do this by lowering the **speed** and increasing the **drag**.
- During **landing** flaps are **fully extended** and during **takeoff** flaps are **partially extended**.



Tricycle Under-carriage

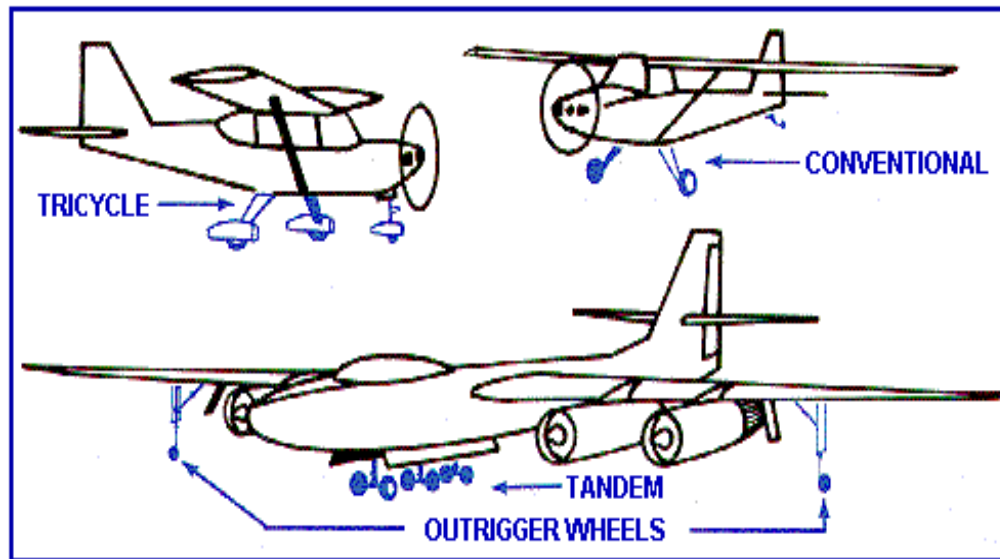
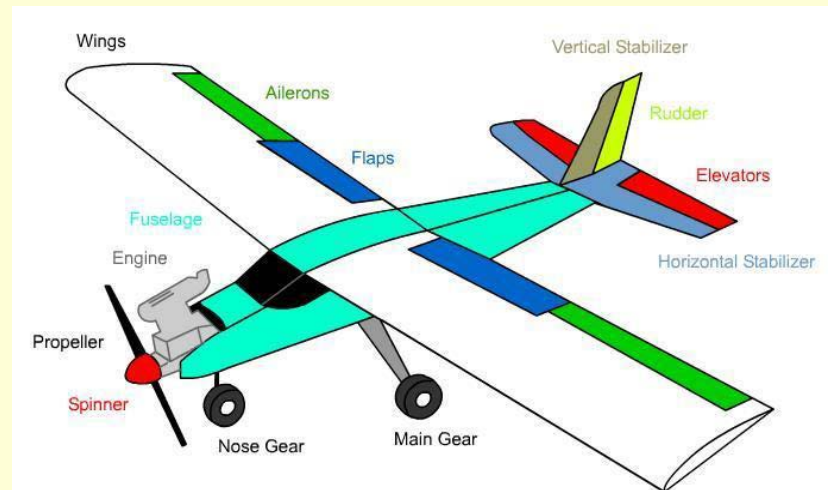


Figure 1-8 Three basic types of landing gear arrangements



Tri-cycle Under-Carriage

- It is structure to support aircraft while it is in contact with the ground.
- Functions :
 1. To absorb landing shocks
 2. To enable the aircraft to manoeuvre on ground





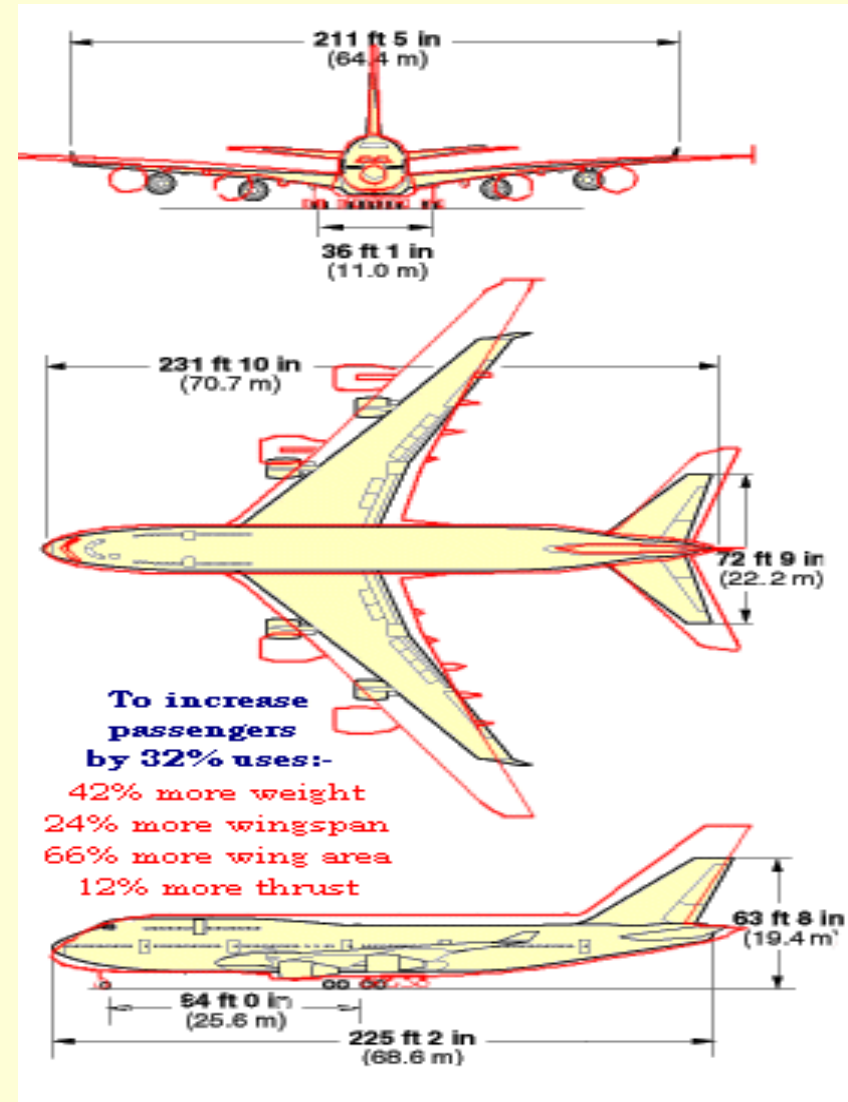
Aircraft Characteristics



Aircraft Characteristics

● Importance : (?)


- Aircraft characteristics are of prime importance to the airport planner and designer.



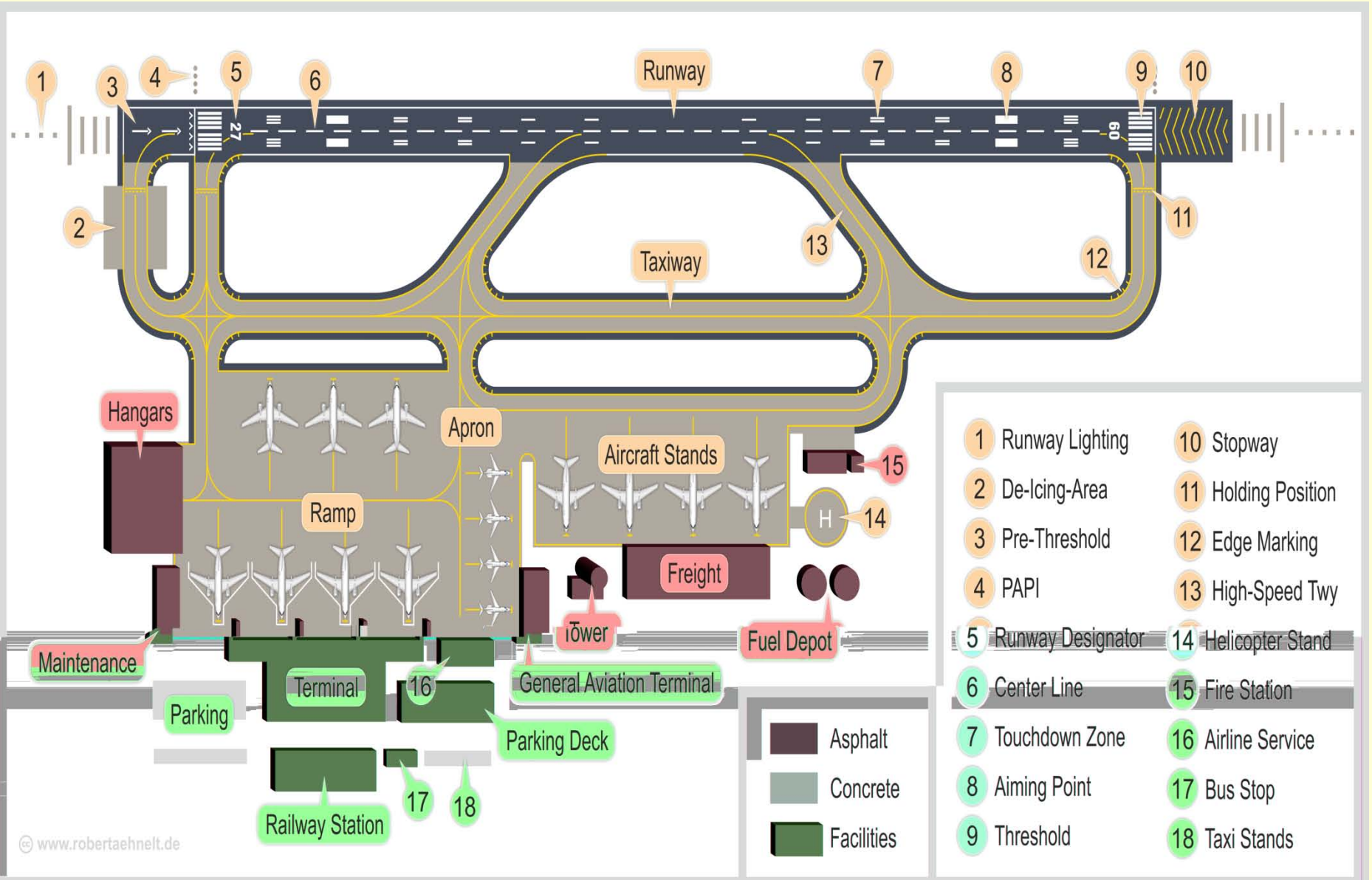


Aircraft Characteristics

● Types of Characteristics :

1. Size of aircraft
 2. Minimum turning radius
 3. Minimum circling radius
 4. Speed of aircraft
 5. Capacity of aircraft
 6. Aircraft weight and wheel configuration
 7. Jet blast
 8. Fuel spillage
 9. Noise
 10. Type of propulsion
- 

Typical Layout of Airport:






Aircraft Characteristics

● Types of Characteristics :

1. Size of aircraft

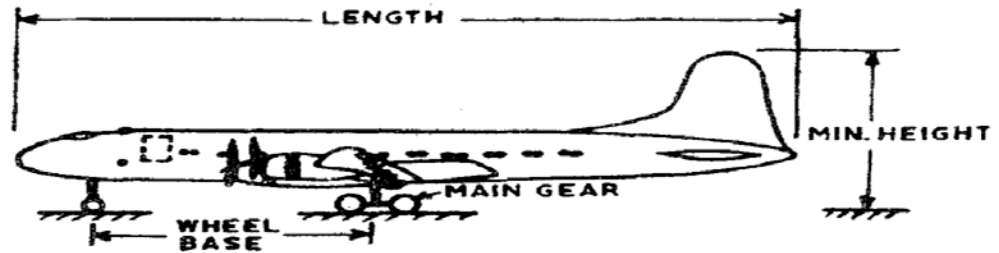
This includes following dimensions:

- Wing span
 - Fuselage length (from nose to tail)
 - Height (at Tail)
 - Gear tread (Distance between main gears)
 - Wheel base (distance between nose gear and main gear)
 - Tail width
- 

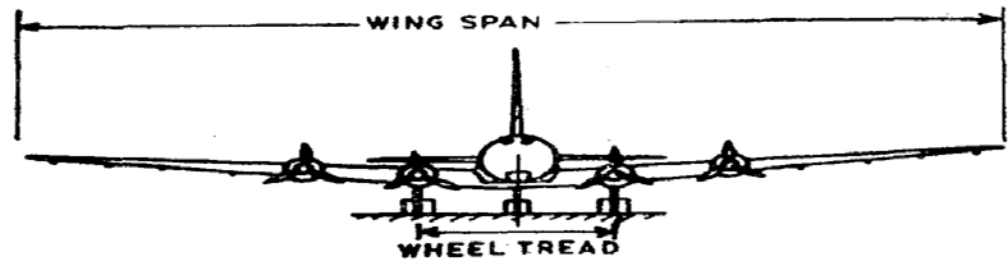
Types of Characteristics :

1. Size of aircraft

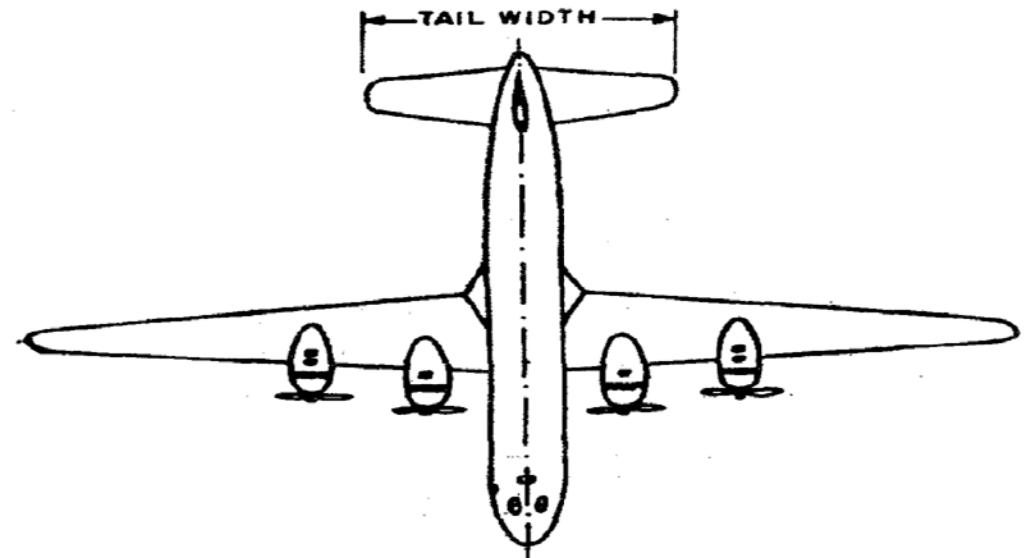
- Wing span
- Fuselage length
(from nose to tail)
- Height (at Tail)
- Gear tread (Distance between main gears)
- Wheel base
(distance between nose gear and main gear)
- Tail width



(a)



(b)



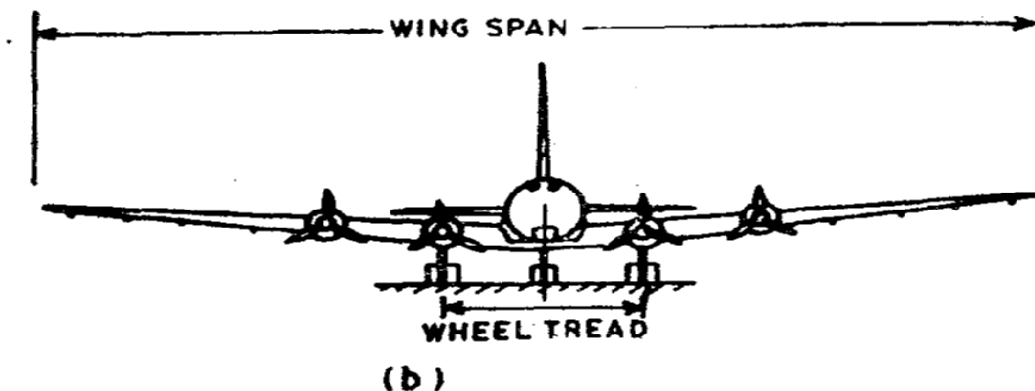
(c)

Aircraft Characteristics

● Types of Characteristics : Influencing Characteristics

1. Size of aircraft – wing span

- The **wing span** decides the width of taxiway, separation clearance between two parallel traffic ways, size of aprons and hangars, width of hangar gate etc.

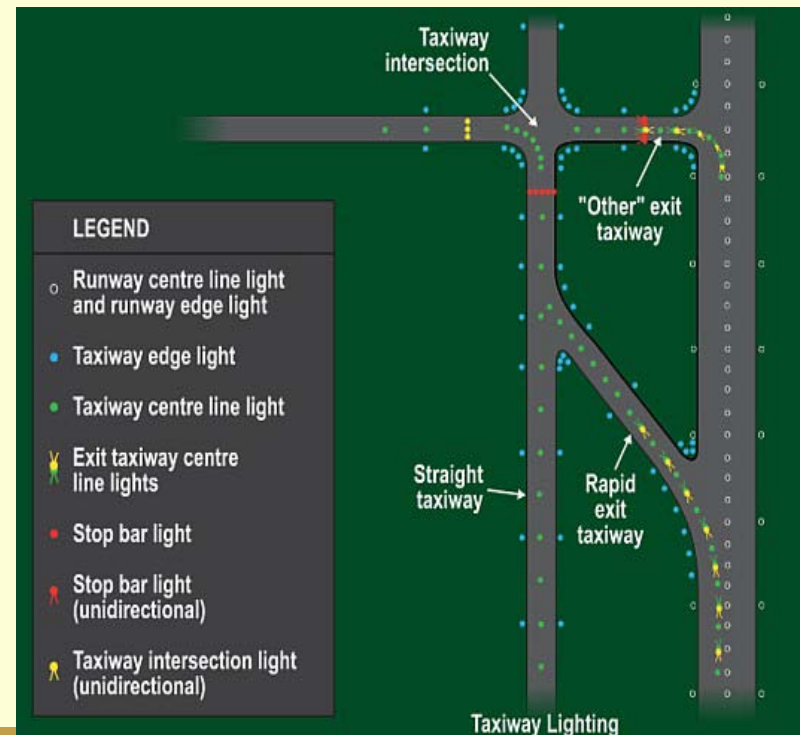
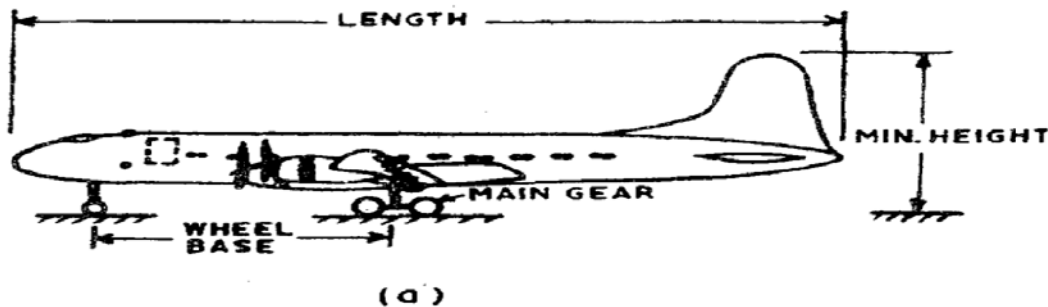


Aircraft Characteristics

Types of Characteristics :

1. Size of aircraft - length

- The **length of aircraft** decides the widening of taxiways on curves, width of exit taxiway, sizes of aprons and hangars etc.

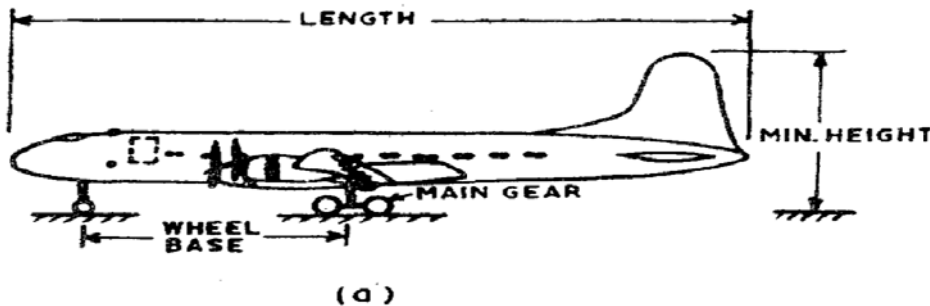


Aircraft Characteristics

Types of Characteristics :

1. Size of aircraft - height

- The **height of aircraft**, also called as **empennage height**, decides the height of hangar gate and miscellaneous installations inside the hangar.

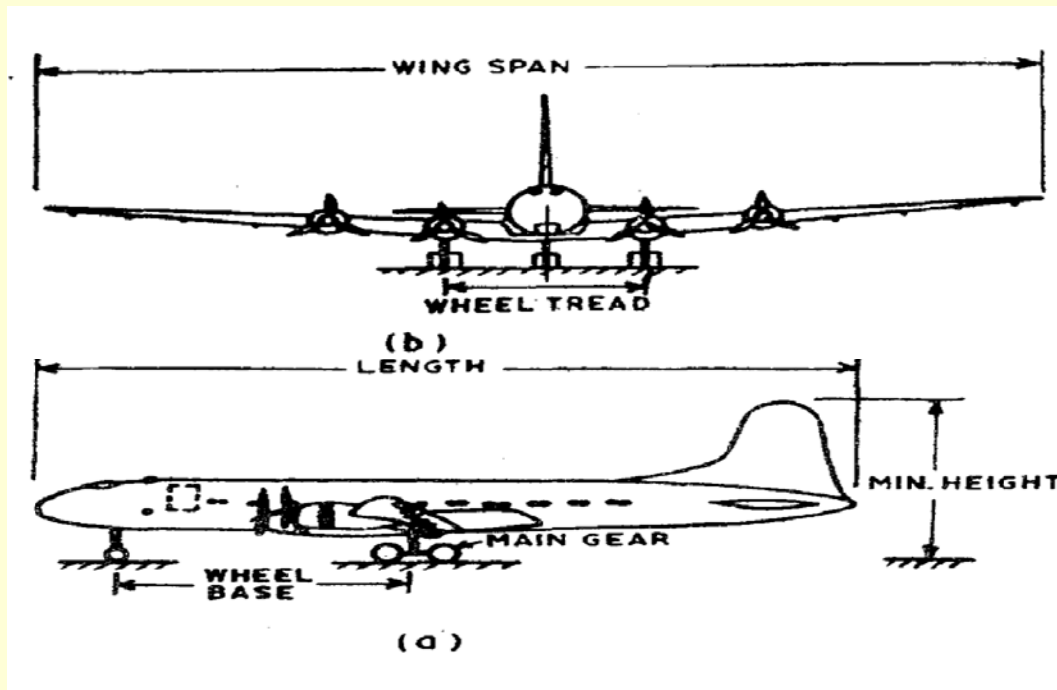


Aircraft Characteristics

Types of Characteristics :

1. Size of aircraft – gear tread , wheel base

- The **gear tread** and the **wheel base** affect the minimum turning radius of the aircraft.

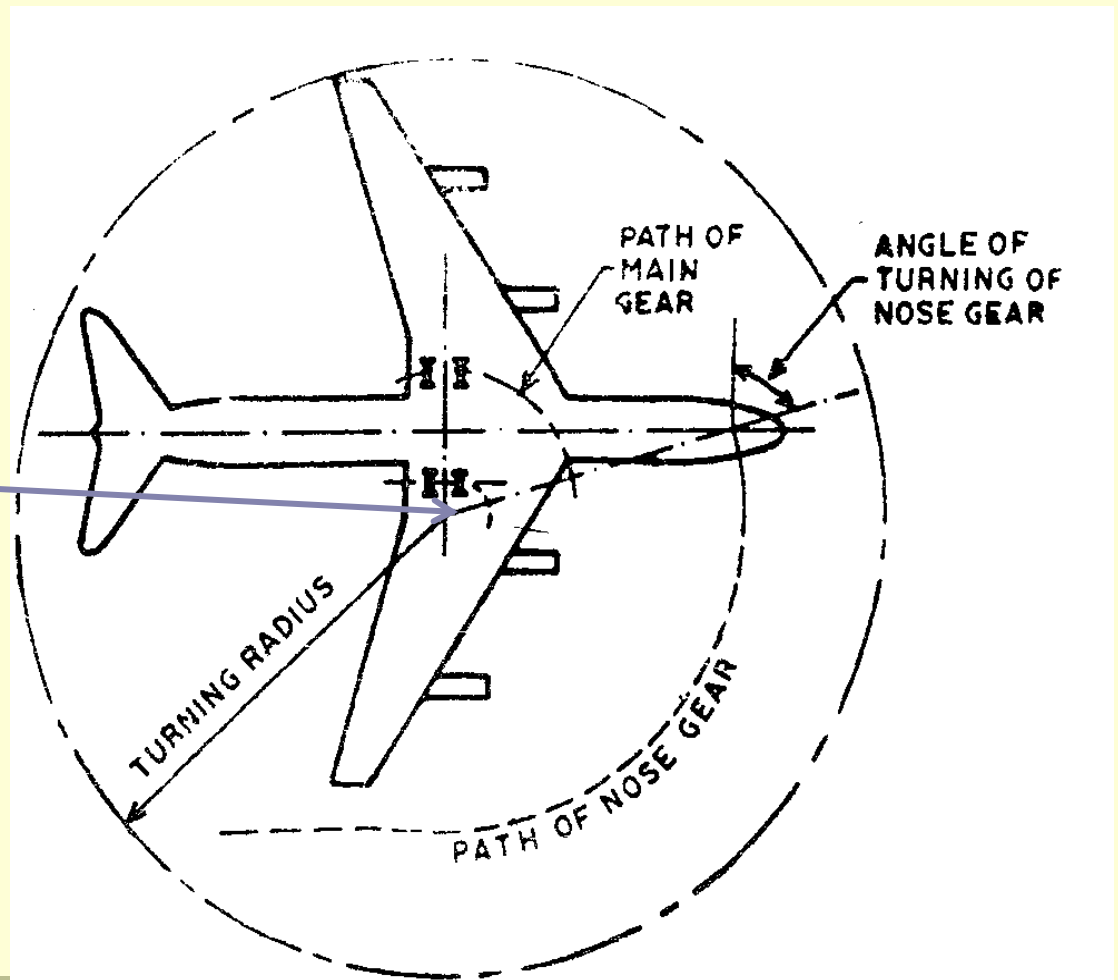


Aircraft Characteristics

- Types of Characteristics :

- 2. Minimum Turning Radius of Aircraft

Point of
Rotation






Aircraft Characteristics

● Types of Characteristics :

2. Minimum Turning Radius of Aircraft


- In order to decide the radius of taxiways, the position of aircrafts in loading aprons and hangars and to establish the path of the movement (nose and main gear) of aircraft, it is very essential to study the geometry of the turning movement of aircrafts.
 - The turning radius of an aircraft is illustrated in the Figure.
- 



Aircraft Characteristics

● Types of Characteristics :

2. Minimum Turning Radius of Aircraft

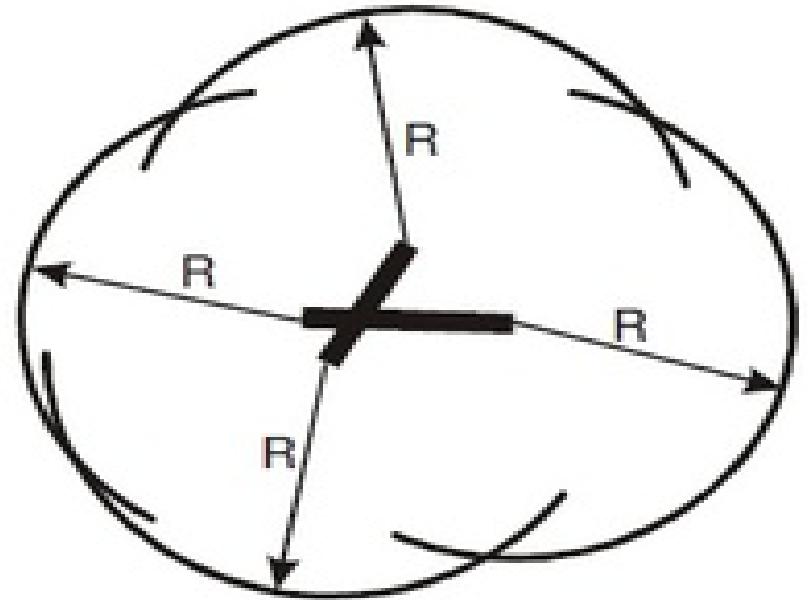
- To determine the minimum turning radius, a line is drawn through the axis of the nose gear when it is at its maximum angle of rotation. The point, where this line intersects another line drawn through the axis of the two main, gears, is called the centre of rotation.
- 

Aircraft Characteristics

Types of Characteristics :

3. Minimum Circling Radius

- There is certain minimum radius with which the aircraft can take turn in space.




Radius of the arcs (R) varies with the aircraft category



Aircraft Characteristics

● Types of Characteristics :

3. Minimum Circling Radius


- This radius depends upon the **type of aircraft, air traffic volume** and **weather conditions**.
 - The radii recommended for different types of aircrafts are as follows :
 - (i) Small general aviation aircrafts, 1.6 km (1 mile)
 - (ii) Bigger aircrafts, say two piston engine = 3.2 km (2 mile)
 - (iii) Piston engine aircrafts = 13 km (8 miles)
 - (iv) Jet engine aircrafts = 80 km (50 miles)
- 



Aircraft Characteristics

● Types of Characteristics :

3. Minimum Circling Radius - decides


- Separation of two near by airports
 - Adjustments of timings of landing and take-off of aircrafts
 - Airport Capacity
 - Zoning laws related to height of obstruction (in turning zone area)
- 



Aircraft Characteristics

- Types of Characteristics :

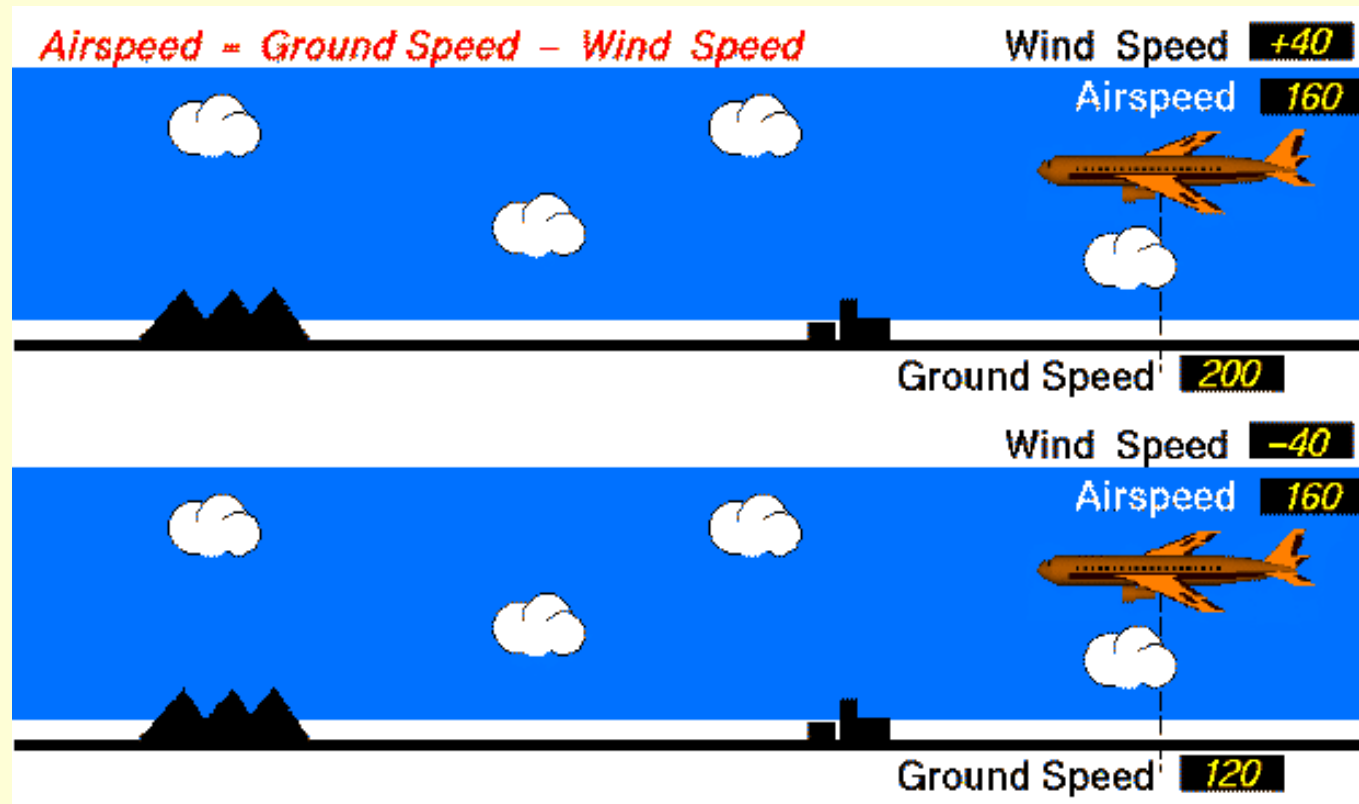
- 4. Speed of Aircrafts

- The speed of aircraft can be defined in two ways viz. **cruising** or **ground speed** and **air speed**.
 - A **tail wind** is a wind that blows in the direction of travel of an object, while a **headwind** blows against the direction of travel.
 - Cruising speed is the speed of aircraft's with **respect to the ground** when the aircraft is flying in air at its maximum speed.
 - Air speed is the speed of aircraft **relative to the wind**.
 - When no wind, $\text{airspeed} = \text{ground speed}$
- 

Aircraft Characteristics

- Types of Characteristics :

- 4. Speed of Aircrafts





Aircraft Characteristics


- Types of Characteristics :

- 4. Speed of Aircrafts - decides

- Journey times

- Increase in frequency of aircraft operations

- Broadening of air network






Aircraft Characteristics

- Types of Characteristics :

5. Aircraft Capacity

- The number of passengers, baggage, cargo and fuel that can be accommodated in the aircrafts depends upon the capacity of aircraft.
 - The capacity of aircraft using an airport have an important effect on the capacity of runway systems as well as that of the passenger processing terminal facilities.
- 

Aircraft Characteristics

Types of Characteristics :

5. Aircraft Capacity






Aircraft Characteristics

- Types of Characteristics :

- 6. (a) Aircraft weight

- Weight of the aircraft directly influence the **length of the runway** as well as the **structural requirements** i.e. the thickness of the runway, taxiway, apron & hangars.
 - It depends not only on the **weight of the passenger baggage, cargo and fuel it is carrying** and its **structural weight**, but also on the fuel which is **continuously decreasing** during the course of the flight.
- 

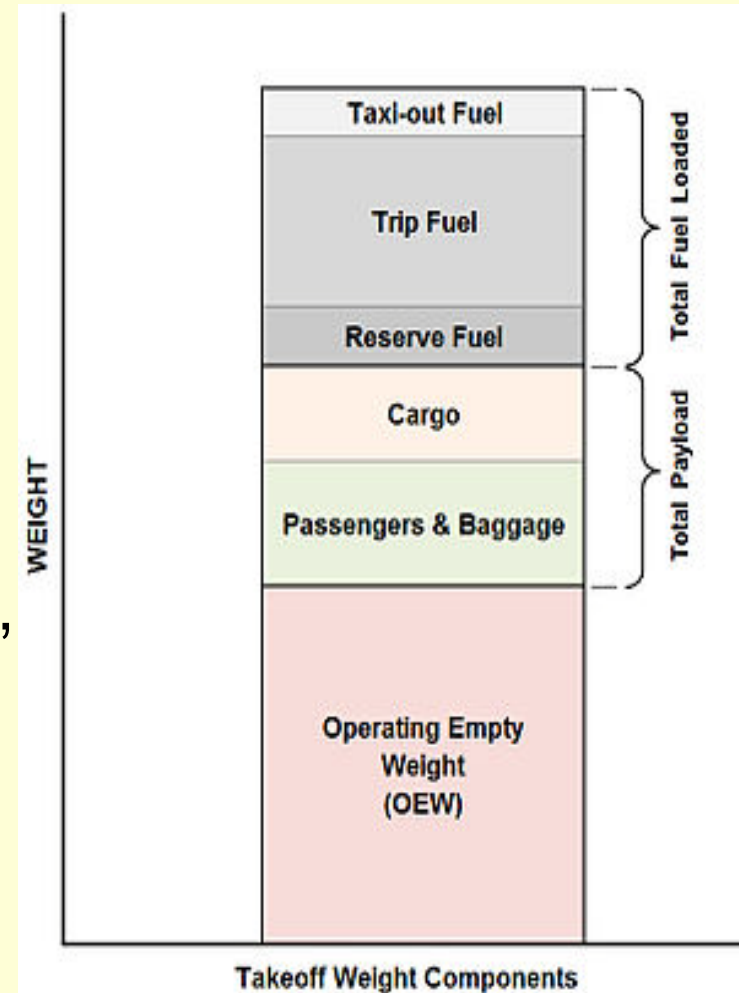
Aircraft Characteristics

Types of Characteristics :

6. (a) Aircraft weight

Types of Aircraft Weights:

1. Operating Empty Weight
2. Pay Load
3. Zero Fuel Weight
4. Maximum Structural Landing Weight,
5. Maximum Gross Takeoff Weight,






Aircraft Characteristics

- Types of Characteristics :

- 6. (b) Aircraft wheel configuration

- The total amount of weight of an aircraft is going to be transferred to the pavement at the bottom.
 - This distribution of load is going to be defined by the wheel configuration and number of wheels being provided.
 - More the number of wheel less is the stress at a certain location.
- 

Aircraft Characteristics

● Types of Characteristics :

6. (b) Aircraft wheel configuration



Single Wheel

Dual Wheel


Twin Tandem Wheel



Aircraft Characteristics

- Types of Characteristics :

- 6. Aircraft weight and wheel configuration – decides

- Thickness of runway, taxiway and apron.
 - Distribution of loads through wheels
 - Generation of revenue
 - Turning
 - Stability of aircraft
- 

Aircraft Characteristics

Types of Characteristics :

7. Jet Blast

- At relatively high velocities, the aircrafts, eject hot exhaust gases.
- The velocity of jet blast may be as high as 300 kmph.
- This high velocity cause inconvenience to the passengers traveling in the aircraft.






Aircraft Characteristics

- Types of Characteristics :

7. Jet Blast


- Several types of **blast forces or jet blast deflector** are available to serve as an effective measure for diverting the smoke ejected by the engine to avoid the inconvenience to the passengers.
 - Since, the **bituminous (flexible) pavements** are affected by the jet blast, therefore, it is desirable to provide **cement concrete pavement** at least at the touch down portion
- 



Aircraft Characteristics

- Types of Characteristics :

- 7. Jet Blast - effects

- Inconvenience, discomfort or even injuries to passengers
 - Hot jet blasts may harm near by aircrafts
- 

Aircraft Characteristics

Types of Characteristics :

8. Fuel Spillage






Aircraft Characteristics

- Types of Characteristics :

8. Fuel Spillage


- Fuel spillage is the **fuel which get spilled** over the pavement from the engine or from the locations where it has been sprayed into the aircraft.
 - This creates an effect **on the speed of the aircraft** while it is moving on the runways or the taxi ways or the front areas.
- 



Aircraft Characteristics

- Types of Characteristics :

8. Fuel Spillage


- At loading aprons and hangars, it is difficult to **avoid spillage completely**, but effort should be made to bring it within minimum limit.
 - The bituminous (flexible pavements) are seriously affected by the fuel spillage and therefore, it is essential that the **areas of bituminous pavements under the fueling inlets, the engines and the main landing gears** are kept under constant supervision by the airport authorities.
- 



Aircraft Characteristics

Types of Characteristics :

9. Noise


- This is one of the big problems in those areas where the airports are being located very near to the developed areas
 - Major sources of noises are
 - i. engine noise,
 - ii. machinery noise (prominent during landing)
 - iii. primary jet noise (prominent during taking off)
- 



Aircraft Characteristics

- Types of Characteristics :

9. Noise


- Noise generated by aircraft create problems in making decisions on **layout and capacity**.
 - The correct assessment of future noise patterns **to minimize the effect of surrounding communities**, is essential to the optimal layout of the runways.
- 



Aircraft Characteristics

- Types of Characteristics :

- 9. Noise - effects


- Sleep disturbances,
 - Annoyance
 - Health risks, deafness, heart attack, etc.
 - Loss of concentration
- 



Aircraft Characteristics

- Types of Characteristics :

10. Type of Propulsion


- Propulsion may be through any type of engine – Piston engine, jet engine, ram jet engine, rocket engine, etc.
 - The speed may vary from 500 kmph to 4500 kmph depending upon type of engine.
- 



Aircraft Characteristics

- Types of Characteristics :

- 10. Type of Propulsion - decides

- The size of aircraft, its circling radius, speed characteristic, weight carrying capacity, noise nuisance etc. depend upon the type of propulsion of the aircraft.
 - The performance characteristics of aircrafts, which determine the basic runway length, also depend upon the type of propulsion.
 - That heat nuisance due to exhaust gases is a characteristic of turbo jet and turbo prop engines.
- 

● Characteristics of Principal Aircrafts :

| No of wheels in main gear | No. of Engines | Type of Engine | Maximum Passenger Capacity (No.) | Maximum Landing wt. (kg) | Maximum gross take off wt. (kg) | Minimum turning radius (m) | Wheel base (m) | Distance bet. Main gears (m) | Maximum Height (m) | Length (m) | Wing Span (m) | Model Designation | Manufacturer |
|---------------------------|----------------|----------------|----------------------------------|--------------------------|---------------------------------|----------------------------|----------------|------------------------------|--------------------|------------|---------------|-------------------|--------------|
| 2 | 4 | Turb o jet | 114 | 59,500 | 64,500 | 21.05 | 15.85 | 6.05 | 10.12 | 30.22 | 32.57 | 727 | Boei ng |
| 4 | 4 | Turb o jet | 189 | 90,000 | 137,000 | 32.7 | 17.7 | 6.63 | 11.60 | 45.87 | 42.72 | 707-320 | Boei ng |
| 4+4 | 4 | Turb o fan | 555 | 386,000 | 560,000 | 32.34 | 29.67 | 12.46 | 14.59 | 72.73 | 79.75 | A 380-800 | Airb us |



Airport Site Selection






Airport Site Selection

- Specific Aspects:
 1. Air traffic potential
 2. Adequate Access
 3. Sufficient Airspace
 4. Sufficient Land



Airport Site Selection


● Factors affecting site selection:

1. Atmospheric and meteorological conditions
 2. Availability of Land for expansion
 3. Availability of utilities
 4. Development of the surrounding area
 5. Economy of construction
 6. Ground Accessibility
 7. Presence of other airports
- 



Airport Site Selection

● Factors affecting site selection:

- 8. Regional Plan
 - 9. Soil Characteristics and drainage
 - 10. Surrounding obstructions
 - 11. Use of Airport
 - 12. Noise nuisance
 - 13. Topography
- 




Airport Site Selection

● Factors Affecting Site Selection:

□ Atmospheric and Meteorological Conditions

■ Visibility

- Fog, smoke, haze
 - Affected by wind velocity
 - Development of area (industrial or commercial)
 - Causes reduction in frequency and hence in capacity handling
- 

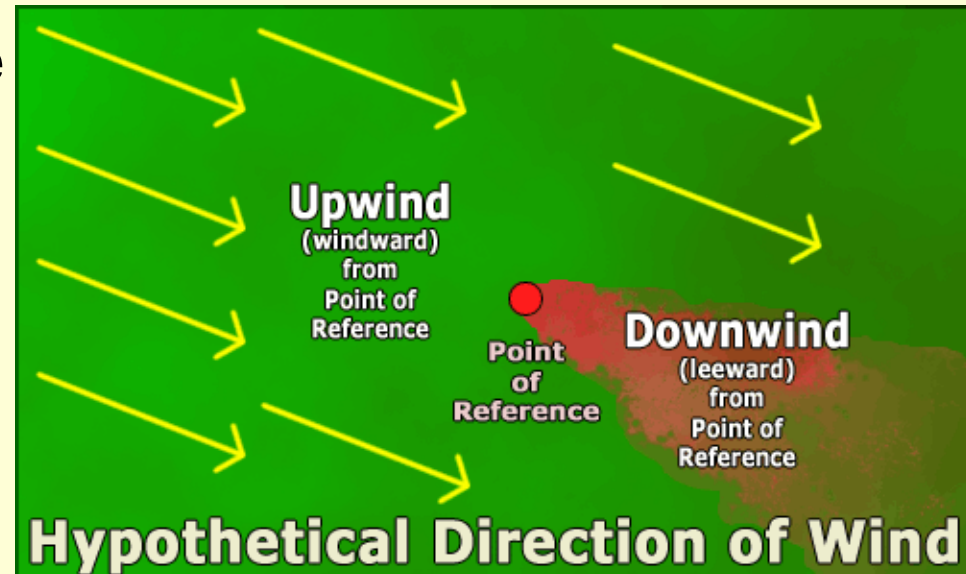
Airport Site Selection

● Factors Affecting Site Selection:

□ Atmospheric And Meteorological Conditions

■ Wind

- Direction and intensity
- Associated topographical features, like hill, valley
- Windward / Leeward side





Airport Site Selection

● Factors Affecting Site Selection:

□ Availability of Land for Expansion

- Future prediction of air traffic
 - Land for parking of vehicles, terminal facilities, apron, runway length, etc.
- Land cost (at later stage)
- Availability of land at later stage






Airport Site Selection

● Factors Affecting Site Selection:

□ Availability of Utilities

- Water, Power, etc.
 - Sewerage
 - Communication
 - Generation Plants
- 



Airport Site Selection

● Factors Affecting Site Selection:

□ Development of Surrounding Area


- Residential or Sensitive area
 - Bird movements and hits
 - Movement of air pollution and noise pollution
 - Industrial development
 - Height of development
 - Zoning laws
- 



Airport Site Selection

● Factors Affecting Site Selection:

□ Economy of Construction


- Alternate sites to be examined
 - Availability of local construction material
 - Uneven terrain, grading or flattening
 - Problematic areas
 - Water logging areas
 - Reclaimed areas
- 



Airport Site Selection

● Factors Affecting Site Selection:

□ Presence of other Airports


- Traffic Volume
 - En-circling radius of aircraft
 - Type of aircraft
 - Type of operating facilities
 - IFR (instrument flight rules), VFR (Visual flight rules)
 - Separation distance between radii
 - May cause
 - Serious air traffic congestion
 - Reduction in airport capacity
- 



Airport Site Selection

● Factors Affecting Site Selection:

□ Ground Accessibility


- Travel time in air v/s travel time on land
 - Easily approachable using all types of modes
 - Proximity of areas of air trip generation
 - Facilities for private vehicle users
 - Efficient transport system
- 



Airport Site Selection

● Factors Affecting Site Selection:

□ Soil Characteristics

- Strength of soil subgrade
 - Bearing on the cost of construction
 - Drainage of soil-self draining
 - Level of water table
 - Subsoil drainage
 - Valley side may have flooding
 - Soil with reasonable amount of pervious material like gravel or sand along with suitable natural binder is good.
- 



Airport Site Selection

● Factors Affecting Site Selection:

□ Use of Airport

- Civil or Military
- Adaptability for other uses during emergencies





Airport Site Selection

● Factors Affecting Site Selection:

□ Surrounding Obstructions

- Clear air space for landing and take-off
 - High-rise structures (man-made)
 - Natural obstructions like trees, etc.
 - Height restrictions and laws
- 